CLAIMS

[1] A three-dimensional magnetic bearing sensor including a first sensor, a second sensor, and a third sensor each constituted by a magneto-impedance sensor element comprising a magnetic sensitive member having a characteristic changed responsive to an external magnetic field, an insulator formed to allow penetration of said magnetic sensitive member therethrough, and an electromagnetic coil made up of foil-like conductive patterns arranged in adjacent relation on an outer surface of said insulator,

wherein said first sensor, said second sensor, and said third sensor are disposed such that directions in which said magnetic sensitive members in respective sensors have maximum magnetic field detection sensitivities are substantially orthogonal to each other.

[2] A three-dimensional magnetic bearing sensor according to Claim 1, wherein each of said first sensor, said second sensor, and said third sensor comprises an electrode-wiring substrate having an elongate groove formed therein as a recessed groove, first conductive patterns which are disposed on an inner peripheral surface of said elongate groove to extend across the groove-running direction of said elongate groove and each of which has opposite ends extended to position on the surface of said electrode-wiring substrate, said insulator filled in said elongate groove in

a state that an amorphous wire serving as said magnetic sensitive member penetrates said insulator, and second conductive patterns disposed on an outer surface of said insulator in bridging relation to said elongate groove, and

wherein said electromagnetic coil is a combination of one coil portion constituted by each of said first conductive patterns and the other coil portion constituted by each of said second conductive patterns and electrically connecting respective corresponding ends of said first conductive patterns adjacent to each other.

[3] A three-dimensional magnetic bearing sensor according to Claim 2, wherein said three-dimensional magnetic bearing sensor includes an IC having a substantially rectangular shape with four side wall surfaces and incorporating an electronic circuit formed therein, said first sensor, said second sensor, and said third sensor being all disposed on said IC, and

wherein said third sensor is disposed on one of said side wall surfaces such that the groove-running direction of said elongate groove is substantially matched with the direction of thickness of said IC.

[4] A three-dimensional magnetic bearing sensor according to Claim 3, wherein said first sensor and said second sensor are disposed on two of the side wall surfaces of said IC which are orthogonal to each other, and the groove-running

direction of said elongate groove of each of said first sensor and said second sensor is substantially orthogonal to the side wall surface on which the other sensor is disposed.

[5] A three-dimensional magnetic bearing sensor according to Claim 3, wherein said third sensor has electrodes formed on a surface thereof which is positioned to face the same side as that of the surface of said IC, and said electrodes are electrically connected to electrodes disposed on the surface of said IC via leads.

[6] A three-dimensional magnetic bearing sensor according to Claim 4, wherein said third sensor has electrodes formed on a surface thereof which is positioned to face the same side as that of the surface of said IC, and said electrodes are electrically connected to electrodes disposed on the surface of said IC via leads, and

wherein each of said first sensor and said second sensor has electrodes formed on a surface thereof which is positioned to face the same side as that of the surface of said IC, and said electrodes are electrically connected to electrodes disposed on the surface of said IC via leads.

[7] A three-dimensional magnetic bearing sensor according to Claim 6, wherein said three-dimensional magnetic bearing sensor has dimensions within 3 mm in length, 3 mm in width and 1.5 mm in height.

[8] A three-dimensional magnetic bearing sensor according

to Claim 2, wherein said three-dimensional magnetic bearing sensor includes an IC incorporating an electronic circuit formed therein and a common substrate on which said IC is mounted, said first sensor, said second sensor, and said third sensor being all disposed on said common substrate, and

wherein said third sensor is disposed such that the groove-running direction of said elongate groove is substantially matched with the direction of thickness of said common substrate.

[9] A three-dimensional magnetic bearing sensor according to Claim 1, wherein in each of said first sensor, said second sensor, and said third sensor, said insulator is formed on an outer periphery of an amorphous wire or a magnetic anisotropic thin film serving as said magnetic sensitive member, and said electromagnetic coil is constituted by said conductive patterns arranged on the outer peripheral surface of said insulator.

[10] A three-dimensional magnetic bearing sensor according to Claim 9, wherein said three-dimensional magnetic bearing sensor includes an IC having a substantially rectangular shape with four side wall surfaces and incorporating an electronic circuit formed therein, said first sensor, said second sensor, and said third sensor being all disposed on said IC, and

wherein said third sensor is surface-mounted to a daughter substrate which is disposed on one of said side wall surfaces in substantially orthogonal relation to the surface of said IC, and a direction in which said magnetic sensitive member in said third sensor has a maximum magnetic field detection sensitivity is substantially matched with the direction of thickness of said IC.

[11] A three-dimensional magnetic bearing sensor according to Claim 10, wherein said first sensor and said second sensor are disposed on the surface of said IC.

[12] A three-dimensional magnetic bearing sensor according to Claim 10, wherein said third sensor has electrodes positioned to face a mount surface of said daughter substrate and is surface-mounted to said daughter substrate in a state that said electrodes are abutted with corresponding electrodes on said daughter substrate.

[13] A three-dimensional magnetic bearing sensor according to Claim 11, wherein said third sensor has electrodes positioned to face a mount surface of said daughter substrate and is surface-mounted to said daughter substrate in a state that said electrodes are abutted with corresponding electrodes on said daughter substrate, and

wherein each of said first sensor and said second sensor has electrodes positioned to face the surface of said IC and is disposed in a state that said electrodes are

abutted with corresponding electrodes on said IC.

[14] A three-dimensional magnetic bearing sensor according to Claim 13, wherein said three-dimensional magnetic bearing sensor has dimensions within 3 mm in length, 3 mm in width and 1.5 mm in height.

[15] A three-dimensional magnetic bearing sensor according to Claim 9, wherein said three-dimensional magnetic bearing sensor includes an IC incorporating an electronic circuit formed therein and a common substrate on which said IC is mounted, said first sensor, said second sensor, and said third sensor being all disposed on said common substrate, and

wherein said third sensor is disposed such that a direction in which said magnetic sensitive member in said third sensor has a maximum magnetic field detection sensitivity is substantially matched with the direction of thickness of said common substrate.

[16] A magneto-impedance sensor element made by winding an electromagnetic coil around a magnetic sensitive member having a characteristic changed responsive to an external magnetic field,

wherein said magneto-impedance sensor element comprises a sensor substrate for holding said magnetic sensitive member, an insulator formed to allow penetration of said magnetic sensitive member therethrough, and an

electromagnetic coil made up of foil-like conductive patterns arranged in adjacent relation on an outer surface of said insulator, and

wherein said sensor substrate has electrodes extended from said electromagnetic coil and said magnetic sensitive member, said electrodes being formed on one of outer surfaces of said sensor substrate which is substantially orthogonal to the axial direction of said magnetic sensitive member.

[17] A magneto-impedance sensor element according to Claim 16, wherein said magneto-impedance sensor element comprises an electrode-wiring substrate serving as said sensor substrate and having an elongate groove formed therein as a recessed groove, first conductive patterns which are disposed on an inner peripheral surface of said elongate groove to extend substantially perpendicularly to the groove-running direction of said elongate groove and each of which has opposite ends extended to position on the surface of said electrode-wiring substrate, said insulator filled in said elongate groove in state that an amorphous wire serving as said magnetic sensitive member penetrates said insulator, and second conductive patterns disposed on an outer surface of said insulator in bridging relation to said elongate groove, and

wherein said electromagnetic coil is a combination of

one coil portion constituted by each of said first conductive patterns and the other coil portion constituted by each of said second conductive patterns and electrically connecting respective corresponding ends of said first conductive patterns adjacent to each other.

[18] A magneto-impedance sensor element according to Claim 16, wherein said magneto-impedance sensor element comprises an insulator covering an outer periphery of an amorphous wire or a magnetic anisotropic thin film serving as said magnetic sensitive member, said electromagnetic coil constituted by said conductive patterns arranged on the outer peripheral surface of said insulator, and a daughter substrate serving as said sensor substrate on which said insulator receiving said magnetic sensitive member therein is disposed.